INTERNATIONAL MASTER OF COMPUTATIONAL MECHANICS

UNIVERSITY OF DUISBURG-ESSEN

Master's Thesis in Computational Mechanics

Investigating the Impact of Randomness in Reproducibility in Computer Vision

A Study on Applications in Civil Engineering and Medicine

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UNIVERSITÄT DUISBURG ESSEN

Offen im Denken

Master Thesis

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A Study on Applications in Civil Engineering and Medicine

Faculty of Engineering
University of Duisburg-Essen

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Declaration

I hereby declare that this master's thesis is my original work, and I have appropriately acknowledged and cited all sources and materials used.

Location: Essen Date: 13.09.2023

Signature: ______________________________ Name: Bahadir Eryilmaz

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Last but not least, I would like to acknowledge the academic community for their valuable contributions to the field of [Your research area]. The collective efforts of researchers and scholars in advancing knowledge have been instrumental in shaping this work.

Abstract

Contents

1. Introduction

Deep learning is a branch of machine learning that uses neural networks to learn from data and perform tasks such as computer vision, which is the field of study that enables machines to understand and analyze visual information such as images and videos. Computer vision algorithms analyze certain criteria in images and videos, and then apply interpretations to predictive or decision-making tasks. Most recent computer vision algorithms are deep learning based, as they can leverage the power of multiple layers of linear and non-linear operations to extract complex features from the input data. Deep learning algorithms use back propagation and weight optimization to adjust the network parameters based on the error between the predicted and actual outputs [1]. However, deep learning and computer vision are not deterministic fields [2]. There are various sources of randomness and irreproducibility that can affect the performance and reliability of deep learning models and computer vision algorithms.

Randomness is in a direct relation with the reproducibility. It introduces an element of unpredictability into the whole training process of neural network. When randomness is involved, it means that the same input conditions can lead to different outcomes as results. Deliberate investigation of this randomness is needed to ensure reproducibility in machine learning. In the thesis, about reproducibility, we adopt the meaning used by Goodman et al. [3] who says it is the ability to obtain the exact same results, by implementing procedures using the same data and tools. Reproducibility is a cornerstone of the scientific method, and it is essential for ensuring that the results of computer vision tasks are valid and can be trusted so that the results could be used when giving decisions about a patient or reliability of a construction site. Reproducibility can also help to minimize the amount of time and resources required for computer vision by reducing the need for additional experimentation to confirm results.

Reproducibility issues in computer vision can have negative consequences, such as unreliable results and reduced confidence in research findings. To ensure that new methods are credible, researchers should share relevant resources such as datasets, trained models, training parameters, and evaluation scripts in their publications. This enables other researchers to replicate the experiments and confirm the results, which can contribute to advancements in the field. Despite these efforts, reproducing the results may still pose challenges due to various factors. [4].

There are several sources of randomness and irreproducibility. Randomness is a source of irreproducibility. We focus on randomness in deep neural networks as a source of irreproducibility. There are implementation level randomness and algorithmic level randomness [2]. In deep learning algorithms, some of this randomness is introduced to prevent algorithm to memorize the data. However, as stated above, there are obvious drawbacks of the randomness. In this study we aim to use three datasets and make experiments on these datasets. In each dataset, we will control deterministic CUDA execution and by fixing other factors we look at the trade offs. Namely, we investigate the randomness caused by the CUDA [5] execution. We, then, investigate how the experiments performed out in the three datasets we are using. It is expected that at each different settings performance will be different. The trade-off between task performance, runtime, and computation costs will be analyzed. Although it is not one of the main goals of this study, we plan to investigate the randomness introduced by the distributed settings as well.

1.1. Section

Table 1.1.: An example for a simple table.

A	B	C	D
1	2	1	2
2	3	2	3

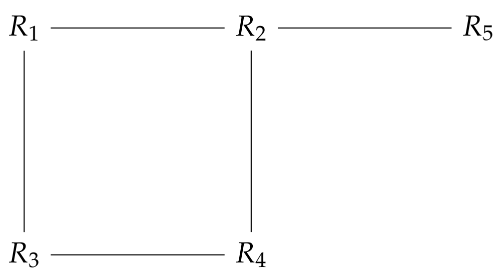

Figure 1.1.: An example for a simple drawing.

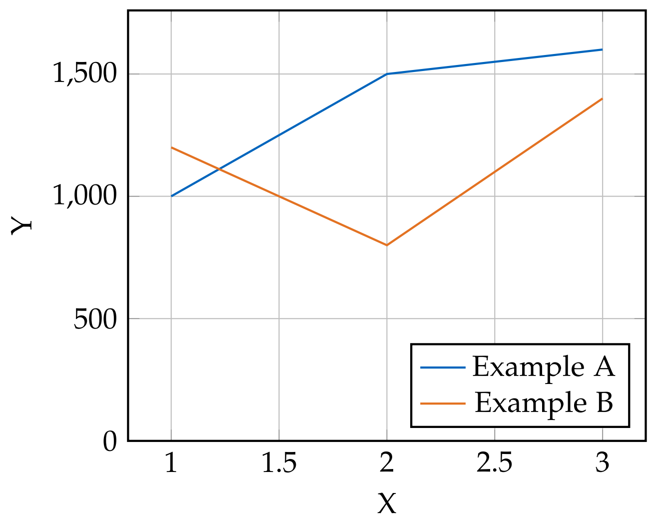

Figure 1.2.: An example for a simple plot.

```
SELECT * FROM tbl WHERE tbl.str = "str"
```

Figure 1.3.: An example for a source code listing.

2. Chapter Two Title

2.1. Section Title

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2.1.1. Subsection Title

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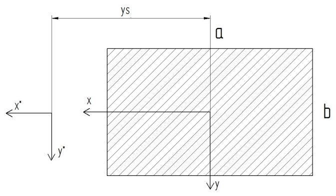
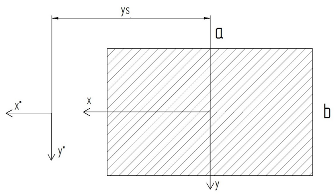
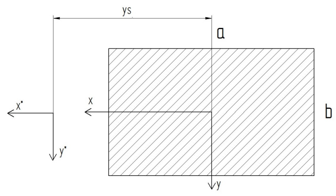


(a) rec 1



(b) rec 2



(c) rec 3

Figure 2.1.: Three simple rectangles

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3. Conclusion

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A. Appendix Title

Abbreviations

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[1] Runai, *Deep Learning for Computer Vision*, Accessed: 29-03-2023.

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